ADT PLM

Programmer's Learning Machine

Matthieu Nicolas

IJD Seminar, 2016-02-02

Outline

Outline

Presentation of PLM

Purposes

- Application to learn programming.

Presentation of PLM

Purposes

- Application to learn programming.
- Allows students to progress at their own speed...

Presentation of PLM

Purposes

- Application to learn programming.
- Allows students to progress at their own speed...
- ... while the teacher helps the ones having trouble.

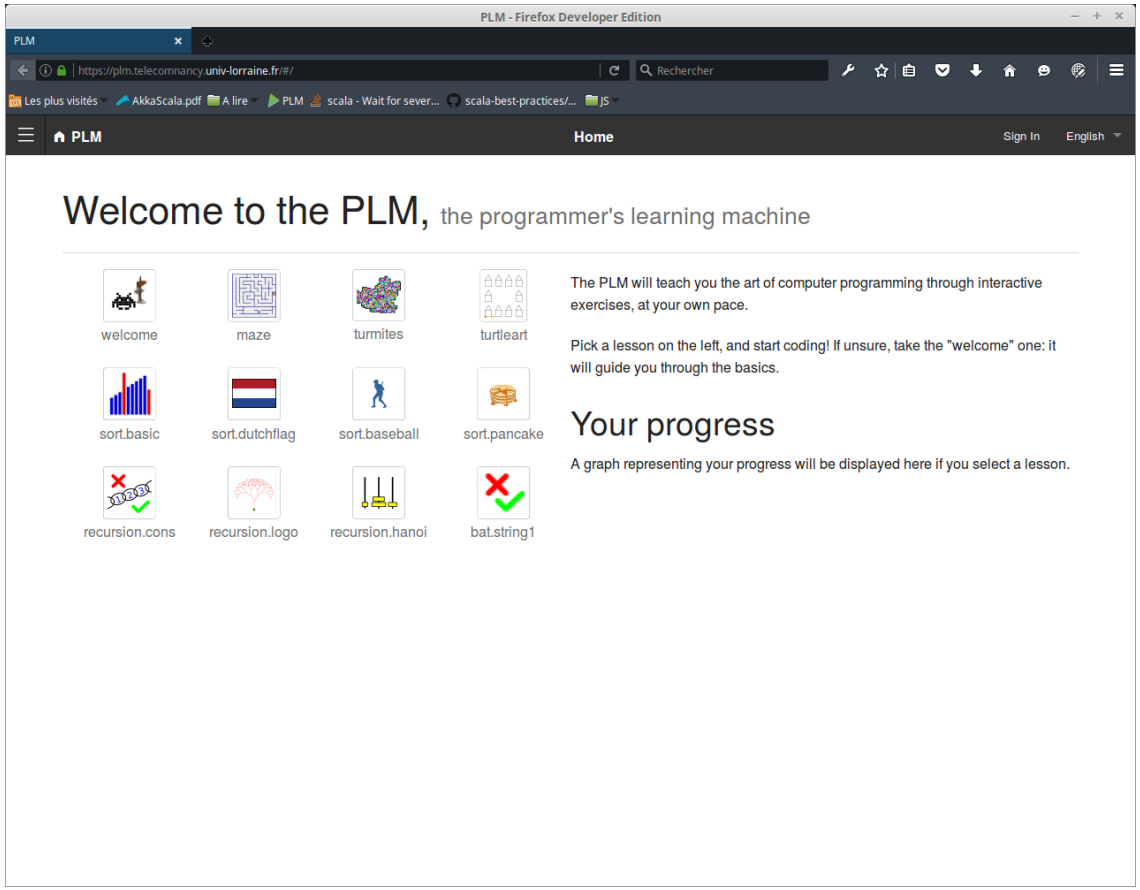
Presentation of PLM

Purposes

- Application to learn programming.
- Allows students to progress at their own speed...
- ... while the teacher helps the ones having trouble.
- Used at TELECOM Nancy since 2008.

Presentation of PLM

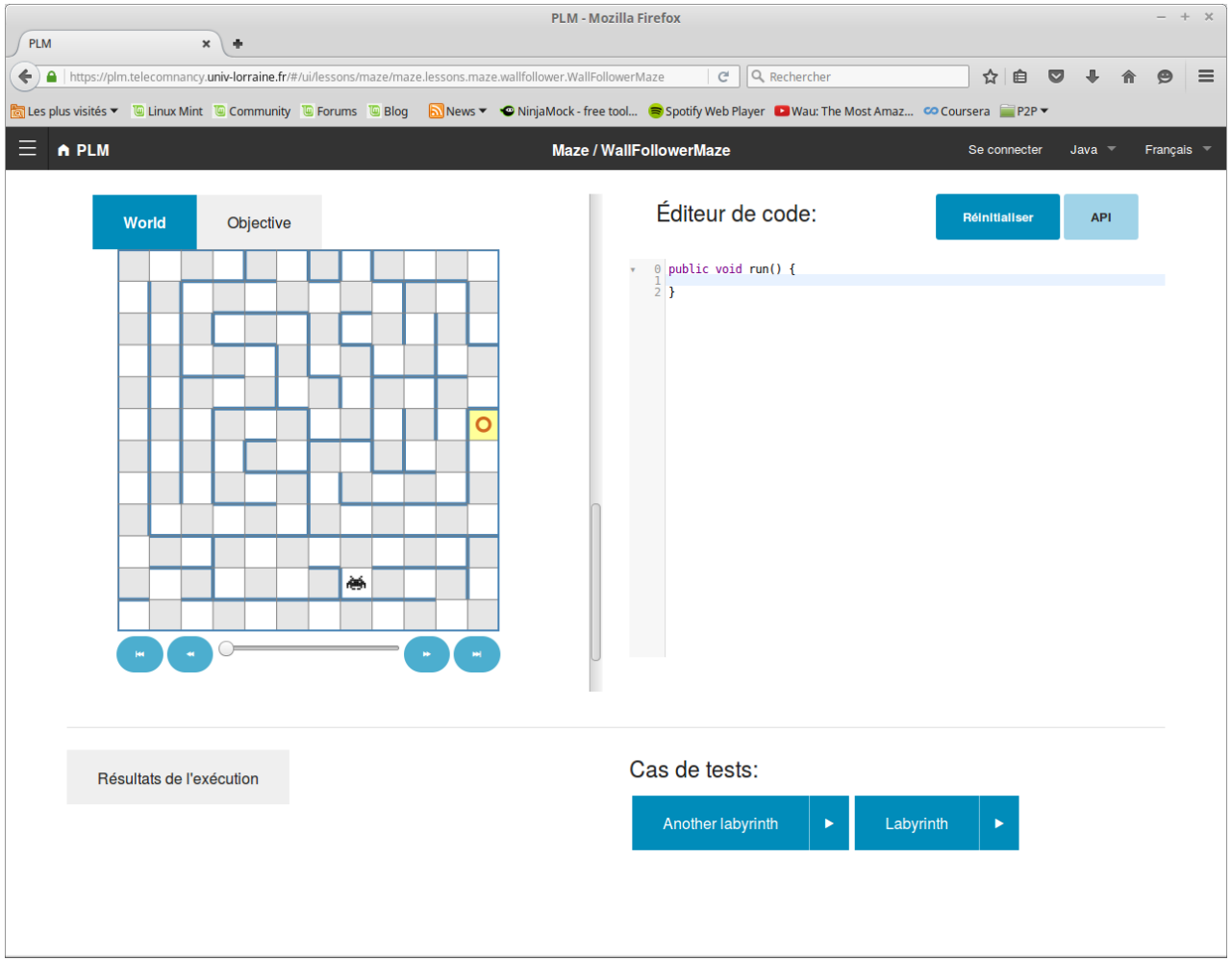
Quick demo



- Available at `https://plm.telecomnancy.univ-lorraine.fr`

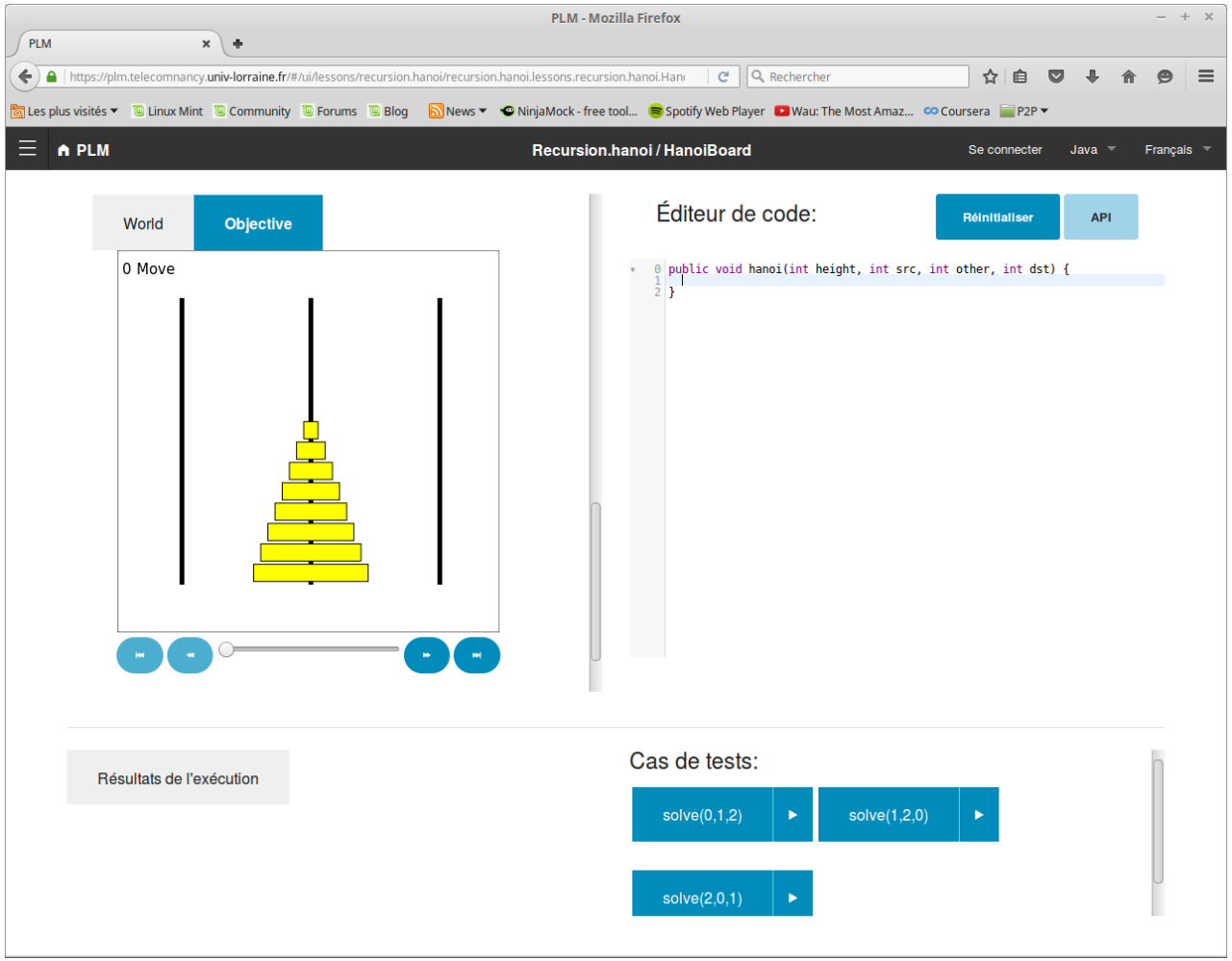
Presentation of PLM

12 lessons, 200 exercises



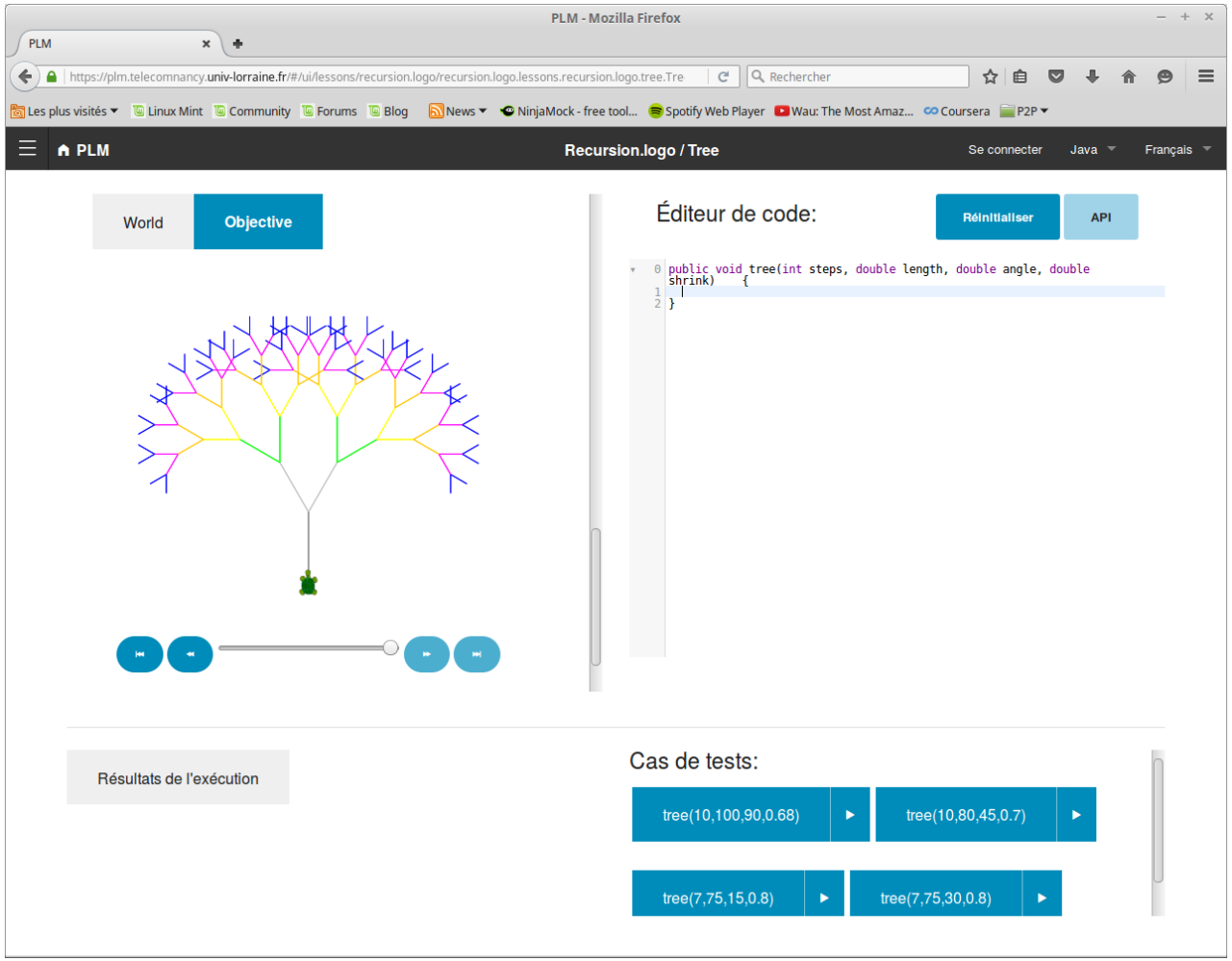
Presentation of PLM

12 lessons, 200 exercises



Presentation of PLM

12 lessons, 200 exercises

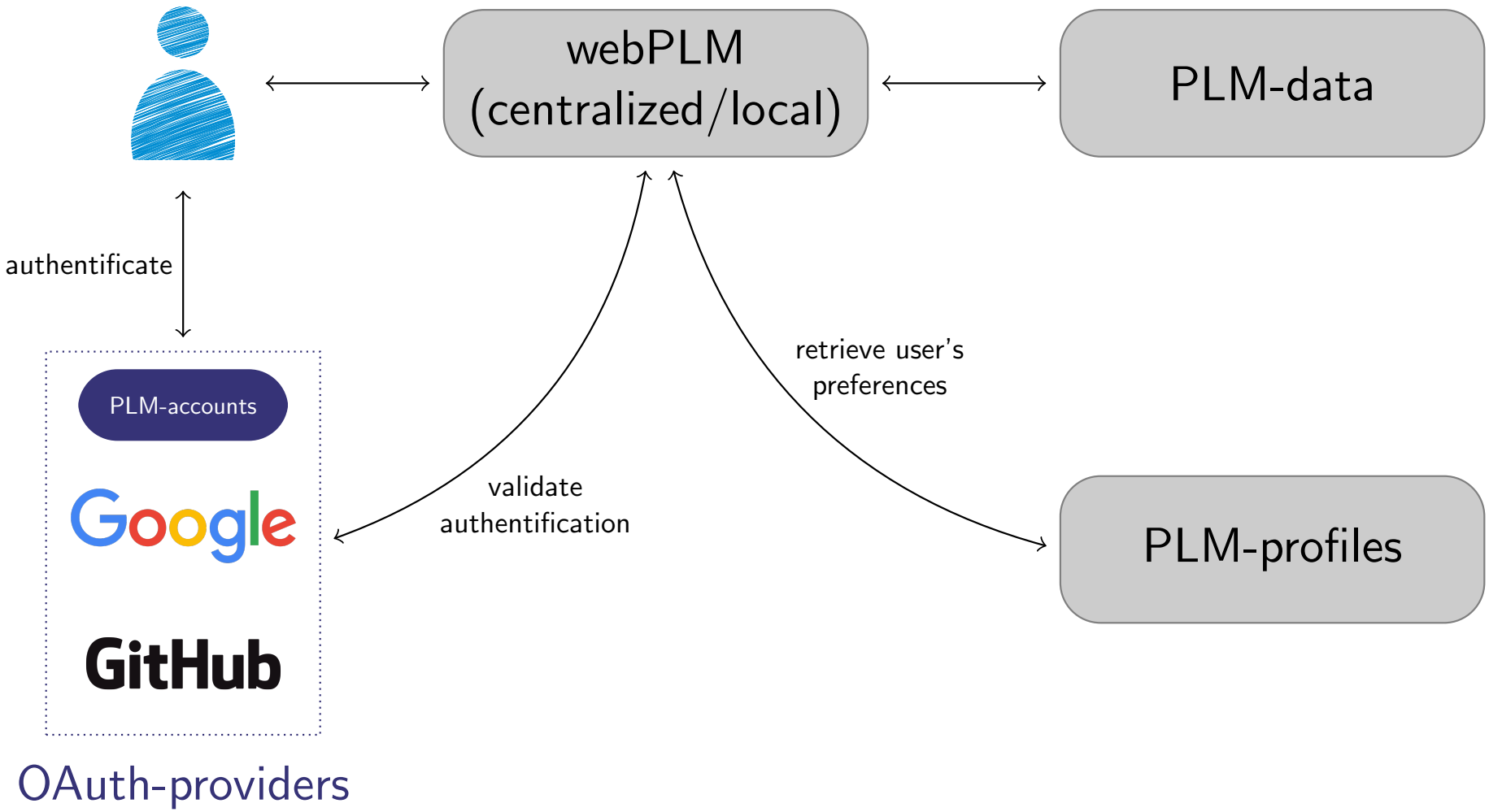


- Available languages:
  - English
  - French
  - Brazilian Portuguese

- Supported programming languages:

Presentation of PLM

Application's architecture



Outline

To a web app

Evolution of the project

- Formerly a fat client
  - Written in Java

To a web app

Evolution of the project

- Formerly a fat client
  - Written in Java
- Switch to a web application
  - Server implemented in Scala using *PlayFramework*
  - User interface written in Javascript using *AngularJS* and *Foundation*

To a web app

Motivations

- More user-friendly
- Aim to setup SPOC[1] and MOOC[2]

- But don't have the time and means for a reboot

[1] Small Private Online Course
[2] Massive Open Online Course

- Implemented a headless version of PLM: *PLM-engine*
  - Provide all PLM's content and methods
  - But without a user interface

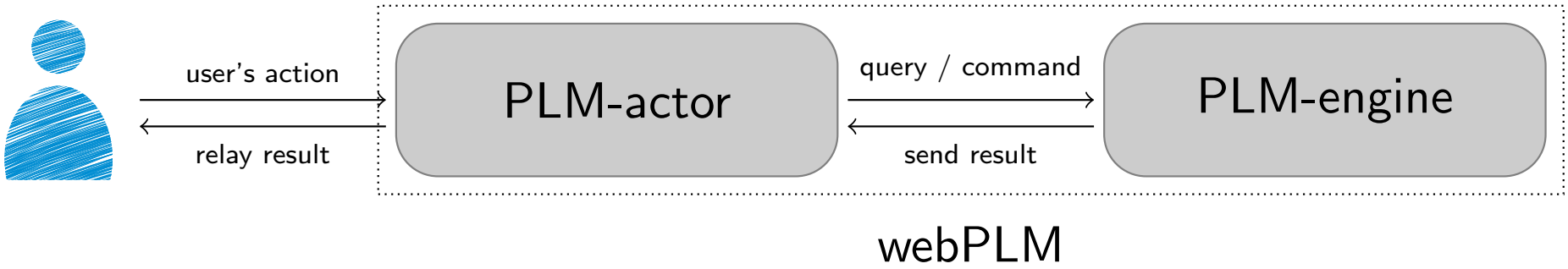
To a web app

Implementing the server

- Designed a communication protocol between the server and the client
  - User's actions sent to server as JSON messages
- Only need to implement an interpreter
  - Parse messages received from the client
  - Query or command PLM-engine according to the message
  - Send back result or acknowledgement to the client

To a web app

Interactions between components



To a web app

Results

- Build quickly a web application from the fat client...
- ... but can't share common ressources among users

Outline

Assessment of user's code

Limits

- Run on the same machine, same JVM

Assessment of user's code

Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
  - Infinite loops

Assessment of user's code

Limits

- Run on the same machine, same JVM

- How to protect ourselves from users' rookie mistakes?
  - Infinite loops
- And from more malicious "mistakes"?
  - Infinite thread creation
  - Endless file creation

Assessment of user's code

Limits

- Run on the same machine, same JVM

- How to protect ourselves from users' rookie mistakes?
  - Infinite loops
- And from more malicious "mistakes"?
  - Infinite thread creation
  - Endless file creation
- And from *System.exit(whatever)*?

Assessment of user's code

Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
  - Infinite loops
- And from more malicious "mistakes"?
  - Infinite thread creation
  - Endless file creation
- And from *System.exit(whatever)*?
- Scalability issues

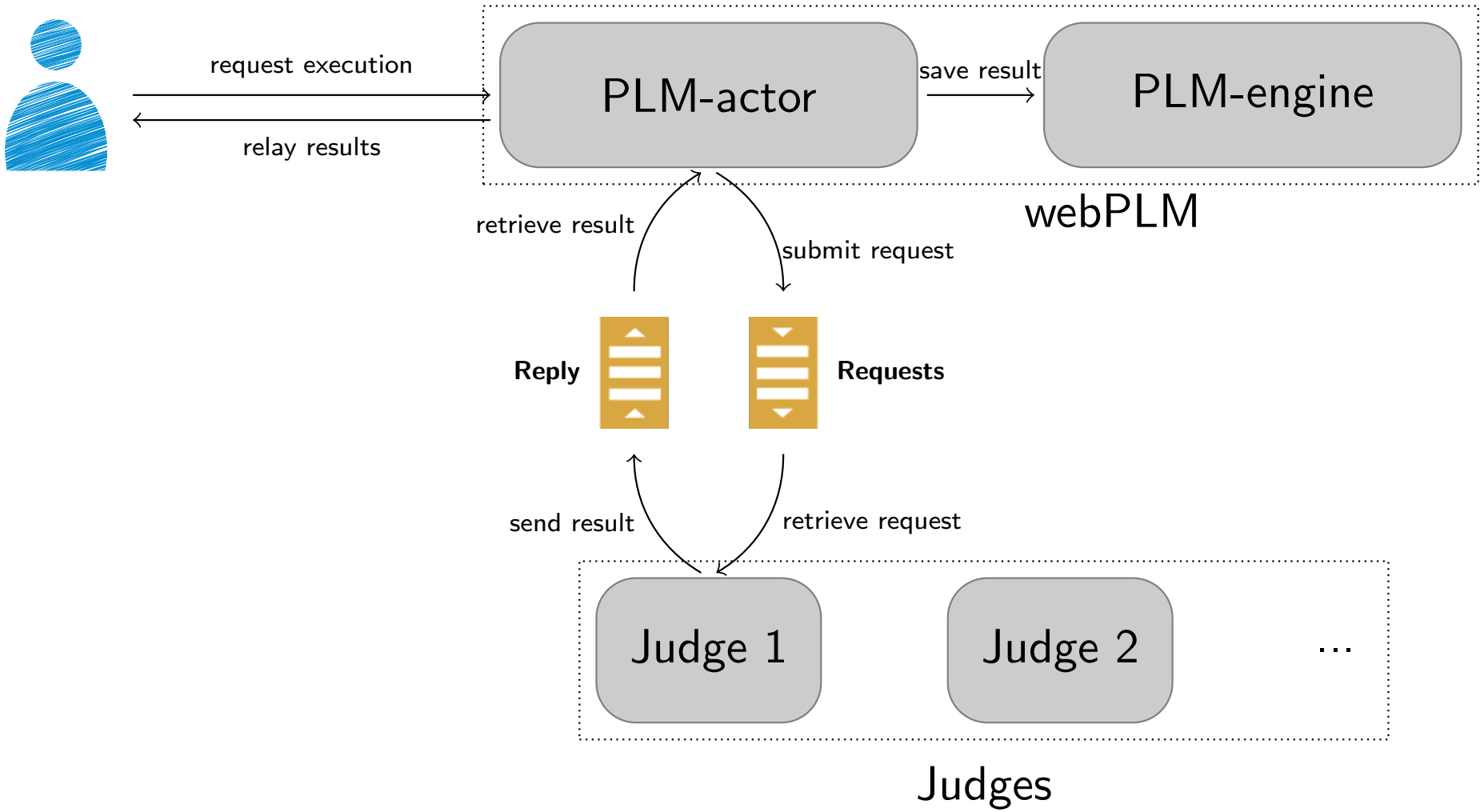
Assessment of user's code

Chosen solution

- Delegate the execution to workers
  - Called *Judges* in the litterature
  - Use PLM-engine as well
  - Execute user's code and send back result to webPLM

Assessment of user's code

Architecture with judges



Assessment of user's code

Implementation

- Distribute workload using message queues
  - One queue for requests
  - One queue per result

Assessment of user's code

Implementation

- Distribute workload using message queues
  - One queue for requests
  - One queue per result
- *Let it crash* strategy
  - Prevent obvious issues with a security manager
  - Handle timeout and crash

Assessment of user's code

Pros and cons

- Pros:
  - Allow to run code without impacting webPLM's performances
  - Meet the scalability requirements

Assessment of user's code

Pros and cons

- Pros:
  - Allow to run code without impacting webPLM's performances
  - Meet the scalability requirements
- Cons:
  - Make sure to use the right version of PLM
  - Need to deploy them easily
  - Should restart them after each execution
  - Have to restrict their resources usage

Assessment of user's code

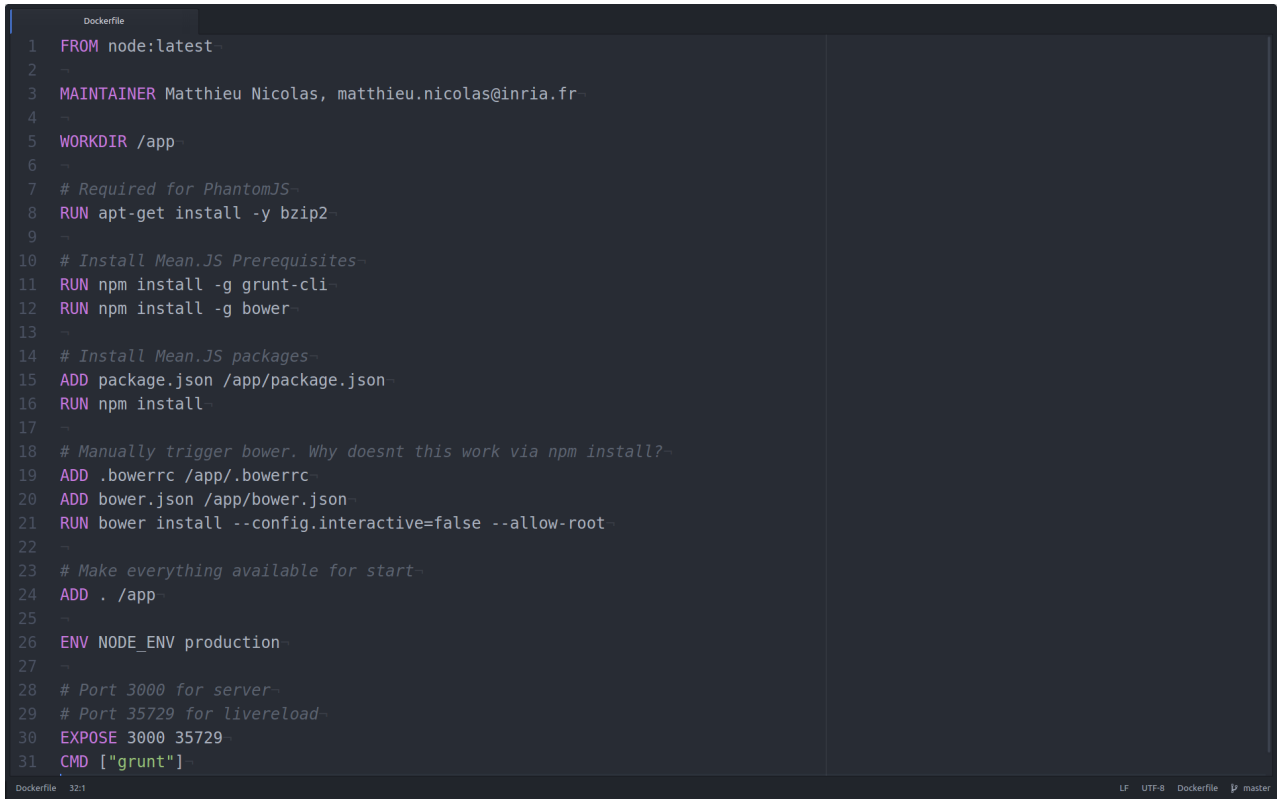
Docker

- Lightweight virtualization tool
- Build image of your application
- Run containers based on images

Assessment of user's code

Example of Dockerfile

- Dockerfiles describe how to set up the application



```
Dockerfile
1  FROM node:latest
2
3  MAINTAINER Matthieu Nicolas, matthieu.nicolas@inria.fr
4
5  WORKDIR /app
6
7  # Required for PhantomJS
8  RUN apt-get install -y bzip2
9
10 # Install Mean.JS Prerequisites
11 RUN npm install -g grunt-cli
12 RUN npm install -g bower
13
14 # Install Mean.JS packages
15 ADD package.json /app/package.json
16 RUN npm install
17
18 # Manually trigger bower. Why doesnt this work via npm install?
19 ADD .bowerrc /app/.bowerrc
20 ADD bower.json /app/bower.json
21 RUN bower install --config.interactive=false --allow-root
22
23 # Make everything available for start
24 ADD . /app
25
26 ENV NODE_ENV production
27
28 # Port 3000 for server
29 # Port 35729 for livereload
30 EXPOSE 3000 35729
31 CMD ["grunt"]
Dockerfile 32:1                                LF UTF-8 Dockerfile master
```

- Run *docker build -t tag /path/to/Dockerfile* to build the image
- Start containers with *docker run tag*

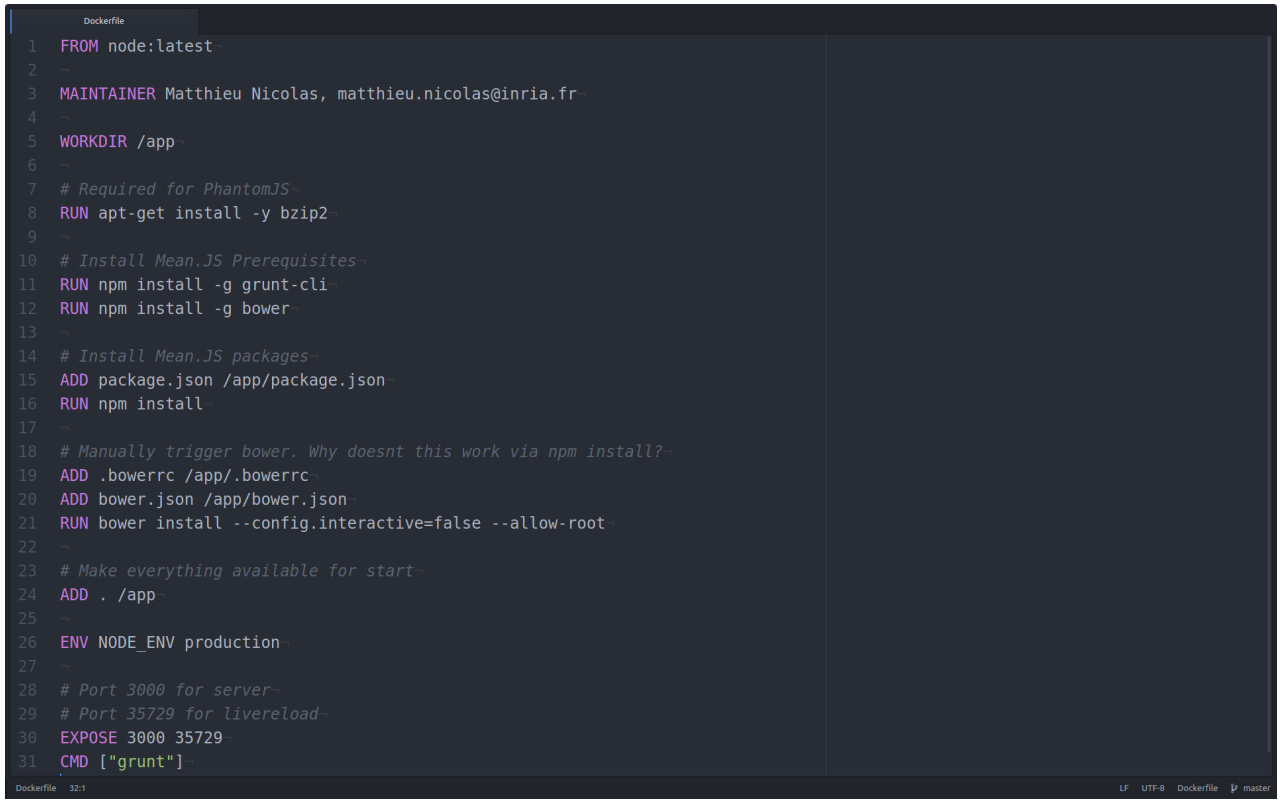
Dockerfile

```
FROM node:latest

MAINTAINER Matthieu Nicolas, matthieu.nicolas@inria.fr

WORKDIR /app

# Required for PhantomJS
RUN apt-get install -y bzip2

# Install Mean.JS Prerequisites
RUN npm install -g grunt-cli
RUN npm install -g bower

# Install Mean.JS packages
ADD package.json /app/package.json
RUN npm install

# Manually trigger bower. Why doesnt this work via npm install?
ADD .bowerrc /app/.bowerrc
ADD bower.json /app/bower.json
RUN bower install --config.interactive=false --allow-root

# Make everything available for start
ADD . /app

ENV NODE_ENV production

# Port 3000 for server
# Port 35729 for livereload
EXPOSE 3000 35729
CMD ["grunt"]
```

Assessment of user's code

Example of Dockerfile

- Dockerfiles describe how to set up the application



- Run *docker build -t tag /path/to/Dockerfile* to build the image
- Start containers with *docker run tag*

Assessment of user's code

More about *docker run*

- Can also manage
  - Ports

Assessment of user's code

More about *docker run*

- Can also manage
  - Ports
  - Volumes

Assessment of user's code

More about *docker run*

- Can also manage
  - Ports
  - Volumes
  - Links between containers

Assessment of user's code

More about *docker run*

- Can also manage
  - Ports
  - Volumes
  - Links between containers
  - Environment variables
  - Runtime constraints on resources
  - Restart policies
  - And a **lot more**

Assessment of user's code

More about *docker run*

- Can also manage
  - Ports
  - Volumes
  - Links between containers
  - Environment variables
  - Runtime constraints on resources
  - Restart policies
  - And a **lot more**

- Commands can become quite complex

docker run -p 443:9443 -link plm-accounts:accounts -v ~/webPLM/logs/:/app/webplm-dist/logs webPLM

Assessment of user's code

Docker-compose

- Tool to easily deploy multi-containers applications

- Deploy environment with *docker-compose up*

docker-compose.yml

```yaml
nginx:
  image: nginx
  ports:
    - "80:80"

messagequeue:
  image: rabbitmq:3-management
  ports:
    - "5672:5672"
    - "15672:15672"

plm:
  image: webplm
  volumes:
    - "~/.plm:/root/.plm"
    - "~/webPLM/logs/:/app/webplm-dist/logs"
  ports:
    - "443:9443"
  environment:
    GITHUB_CLIENT_SECRET:
    GOOGLE_CLIENT_SECRET:
    PLMACCOUNTS_CLIENT_SECRET:
    GITHUB_ACCESS_TOKEN:
  links:
    - accounts
    - profiles
    - messagequeue:messageq

accounts:
  image: plm-accounts
```

docker-compose.yml

```yaml
    GITHUB_CLIENT_SECRET:
    GOOGLE_CLIENT_SECRET:
    PLMACCOUNTS_CLIENT_SECRET:
    GITHUB_ACCESS_TOKEN:
  links:
    - accounts
    - profiles
    - messagequeue:messageq

accounts:
  image: plm-accounts
  ports:
    - "9000:3000"
  links:
    - db

profiles:
  image: plm-profiles
  ports:
    - "8080:3000"
  links:
    - db

db:
  image: mongo
  volumes:
    - "~/mongodb/data:/data/db"
  ports:
    - "27017:27017"
```

Assessment of user's code

Docker-compose

- Tool to easily deploy multi-containers applications

```yaml
nginx:
  image: nginx
  ports:
    - "80:80"

messagequeue:
  image: rabbitmq:3-management
  ports:
    - "5672:5672"
    - "15672:15672"

plm:
  image: webplm
  volumes:
    - "~/.plm:/root/.plm"
    - "~/webPLM/logs/:/app/webplm-dist/logs"
  ports:
    - "443:9443"
  environment:
    GITHUB_CLIENT_SECRET:
    GOOGLE_CLIENT_SECRET:
    PLMACCOUNTS_CLIENT_SECRET:
    GITHUB_ACCESS_TOKEN:
  links:
    - accounts
    - profiles
    - messagequeue:messageq

accounts:
  image: plm-accounts
    GITHUB_CLIENT_SECRET:
    GOOGLE_CLIENT_SECRET:
    PLMACCOUNTS_CLIENT_SECRET:
    GITHUB_ACCESS_TOKEN:
  links:
    - accounts
    - profiles
    - messagequeue:messageq

accounts:
  image: plm-accounts
  ports:
    - "9000:3000"
  links:
    - db

profiles:
  image: plm-profiles
  ports:
    - "8080:3000"
  links:
    - db

db:
  image: mongo
  volumes:
    - "~/mongodb/data:/data/db"
  ports:
    - "27017:27017"
```

- Deploy environment with *docker-compose up*

Assessment of user's code

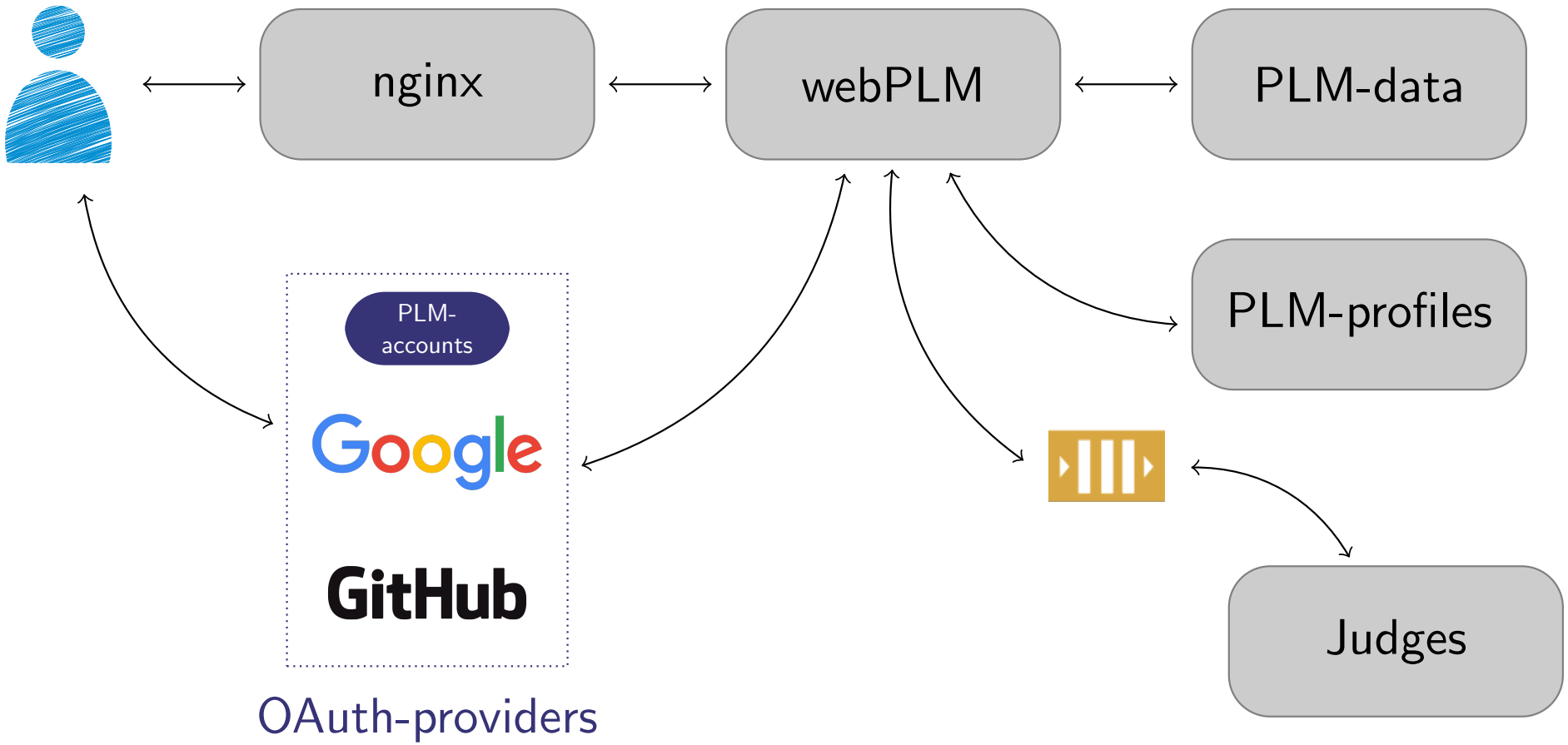
Docker in our case

- Deploy easily all components
- Restart judges automatically
- Limit users' mischiefs

Outline

Result

Current architecture



Result

Live-session in TELECOM Nancy

- Used in TELECOM Nancy in September 2015
- 30 hours of live testing with 100 students

Result

Live-session in TELECOM Nancy

- Used in TELECOM Nancy in September 2015
- 30 hours of live testing with 100 students

- Engine is (almost) working fine...
- ... but user experience needs to be improved!

Result

Live-session in TELECOM Nancy

- Scalability issues:
  - Work well with small exercises
  - Can't cope with workload of larger exercises

Result

Live-session in TELECOM Nancy

- Scalability issues:
  - Work well with small exercises
  - Can't cope with workload of larger exercises
- No tools for monitoring set up...

Result

Live-session in TELECOM Nancy

- Scalability issues:
  - Work well with small exercises
  - Can't cope with workload of larger exercises
- No tools for monitoring set up...
- ... so the bottleneck is unknown.

Outline

Next steps

Refactor the code

- Rushed to release a stable version before September 2015...
- Needed to clean some parts of the code
- Merged local and centralized mode branches

Next steps

Simplify workflow to adapt the content

- Store most of content inside PLM
- Heavy and error prone workflow
- Need to extract the content from PLM's jar
- Allow to implement an exercise editor

Next steps

Solve performance issues

- Set up some monitoring tools
- Perform some load testing to identify the bottleneck

Questions

Thanks for your attention, any questions?